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FIELD PROCEDURES FOR

SOIL-SITE CLASSIFICATION OF PINE LAND

IN SOUTH ARKANSAS AND NORTH LOUISIANA

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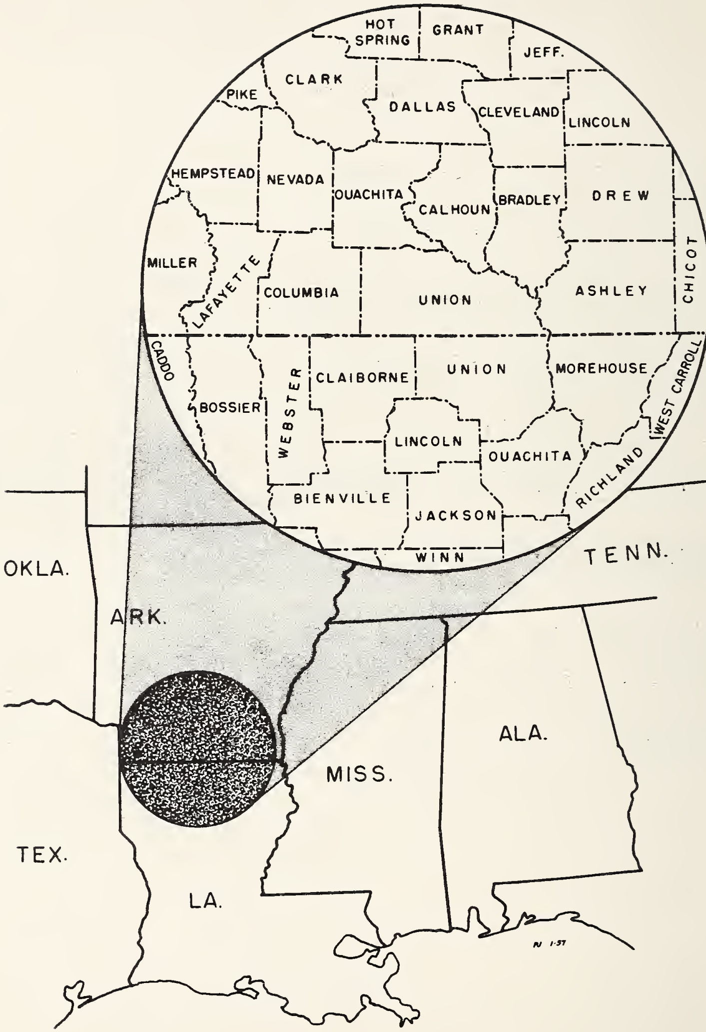

Figure 1.--Area in which field guide applies.

FIELD PROCEDURES FOR SOIL-SITE CLASSIFICATION OF PINE LAND IN SOUTH ARKANSAS AND NORTH LOUISIANA

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This is a field guide for classifying pine site quality in terms of soil and topographic characteristics. It is based on studies of pine growth in relation to soil type in south-central Arkansas and north-central Louisiana.[1]

Basic data were collected from pine forests on upland Coastal Plain and terrace soils within roughly a 60-mile radius of El Dorado, Arkansas (fig. 1). The guide is not intended for use outside this area.

Most sites on which loblolly and shortleaf pines naturally occur can be classified by the system outlined. The method is not applicable, however, to floodplains of major streams, loess deposits, or prairie soils, even within the region studied.

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[1] For the technical aspects of this work, see:
Zahner, R. *Site-quality relationships of pine forests in south Arkansas and north Louisiana.* Forest Science 4: 162-176.

FACTORS AFFECTING SITE QUALITY

The classification system is based on the relationship between site index (i. e., height in feet of dominant trees in fully stocked stands at age 50 years) and permanent features of the soil and topography. These features must be recognized and mapped, then converted to units of site quality.

Three site factors affect site index: (1) thickness or texture of the surface soil, (2) texture of the subsoil, and (3) slope.

Some soils exhibit strong horizon development, where the surface layer is distinctly different from the lower layers. Such soils are called "zonal." The surface soil is grey and sandy, while subsoils are brown, red, or yellow, and contain more clay. The change from one layer to the next is rather abrupt, with a transition zone of one to three inches. Zonal soils occupy most of the slopes and ridges of the rolling Coastal Plain uplands, and may occasionally be found on terraces and other level areas.

Other soils have poor horizon development, and are called "azonal." Their profiles exhibit no distinguishable line between the surface soil and the subsoil. Azonal soils are characteristic of level terraces and upland flatwoods, and are rarely found on slopes over 5 percent.

The thickness of the surface layer is useful in estimating site quality of zonal soils. But on azonal soils this layer gradually blends into the subsoil and its thickness cannot be accurately measured. The

texture of the surface layer is therefore used instead to estimate site on azonal soils.

On both zonal and azonal soils, subsoil texture and percent of slope are necessary measurements for site estimates.

Soil textural characteristics are defined in some detail in the Appendix. The reader should familiarize himself with this material before attempting field application.

Root growth and development of loblolly and shortleaf pines are largely regulated by the soil moisture and soil aeration of a site. When moisture is deficient, growth slows or ceases. When aeration is inadequate (often when moisture is in excess) roots do not permeate the soil to take advantage of all the stored moisture.

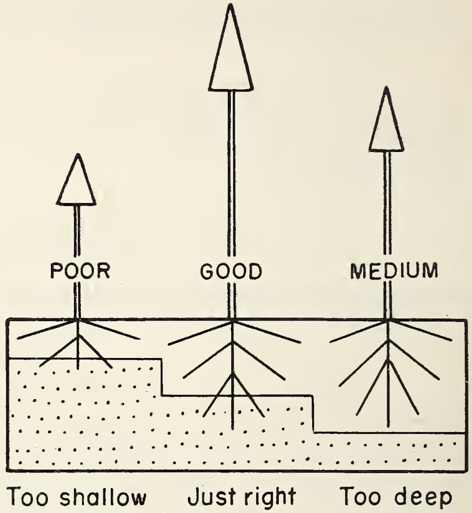
In zonal soils the surface layer is usually well aerated. Its thickness reflects the amount of space roots occupy above the subsoil. When the subsoil is shallow, roots do not have space for adequate development. When the surface soil is very thick, the moisture-holding subsoil is partly out of reach. Eighteen inches seems to be the optimum thickness of surface soil for good pine growth (fig. 2A).

In azonal soils, the surface soil is not always well aerated. The finer the texture the poorer is the root development. Surface soils of low silt content are better sites than those of high silt content (fig. 2B).

The subsoil in all soils plays an important role in supplying stored moisture to the forest. The finer

A. ZONAL SOILS.

HOW THICKNESS OF SURFACE SOIL AFFECTS TREE GROWTH.



B. AZONAL SOILS.

HOW TEXTURE OF SURFACE SOIL AFFECTS TREE GROWTH.

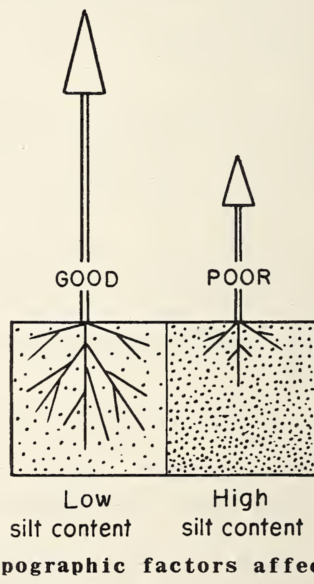


Figure 2.--How soil and topographic factors affect site quality.

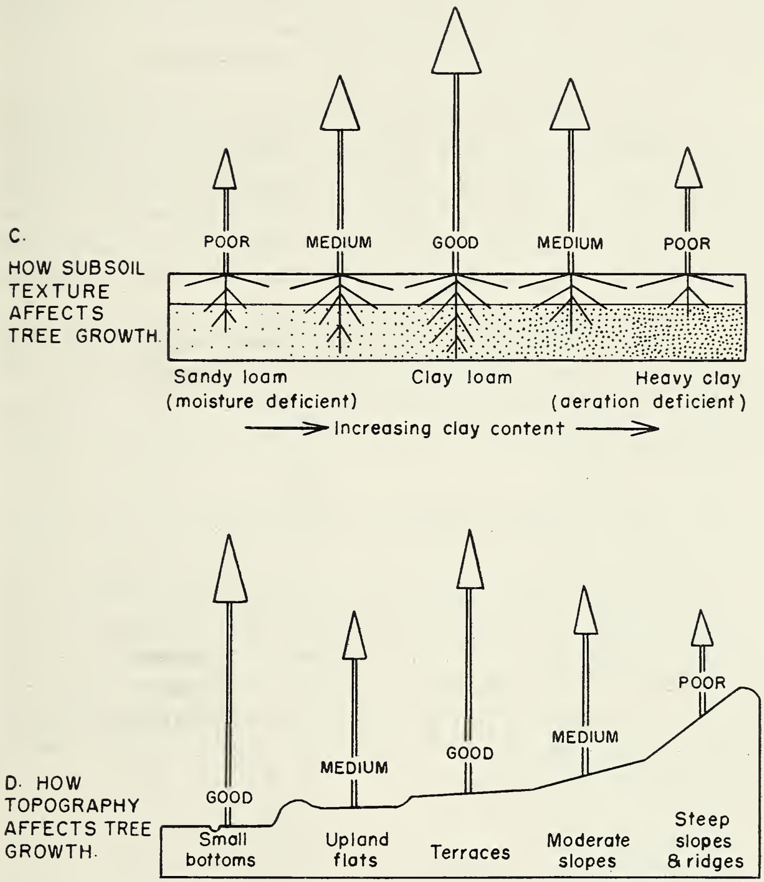


Figure 2.--(continued).

the texture of the subsoil, the better is the moisture-holding capacity. At the same time, however, the poorer is the aeration. Therefore, as might be expected, the best sites are on subsoils with intermediate texture, where moisture is adequate and aeration not limiting (fig. 2C).

Topography also helps to regulate the moisture and aeration regimes of a site. In general, moisture conditions become more favorable for growth as the site changes from steep slopes and ridges to gentle slopes and terraces, while well-drained small stream floodplains offer the most favorable conditions.

As a rule, site index increases with decreasing slopes (fig. 2D). The one exception is the poorly drained upland flat, which is not well aerated and consequently not so favorable a site as a gentle slope.

HOW TO MEASURE SITE FACTORS

A soil auger is all the equipment necessary to measure the soil factors at any one location. The soil should be moist, but not wet, for adequate sampling. It is difficult to obtain accurate information from dry soil. Soil conditions are usually best for sampling in winter, spring, and early summer--except immediately after heavy rains.

SOIL SAMPLING PROCEDURE

A preliminary boring with the auger will tell the investigator whether the soil is zonal or azonal.

If zonal, a definite horizon change will indicate the depth of the surface soil. If azonal, the soil will merely become progressively heavier in texture as the auger goes deeper.

Procedures are modified to conform to horizon development. In zonal soils, of course, the thickness of the surface soil is measured from the ground surface down to the first major change in soil color and texture, or to the topmost subsoil layer (fig. 3A). This is not necessarily the least permeable layer. Next, the textural grade of the subsoil is determined at a point

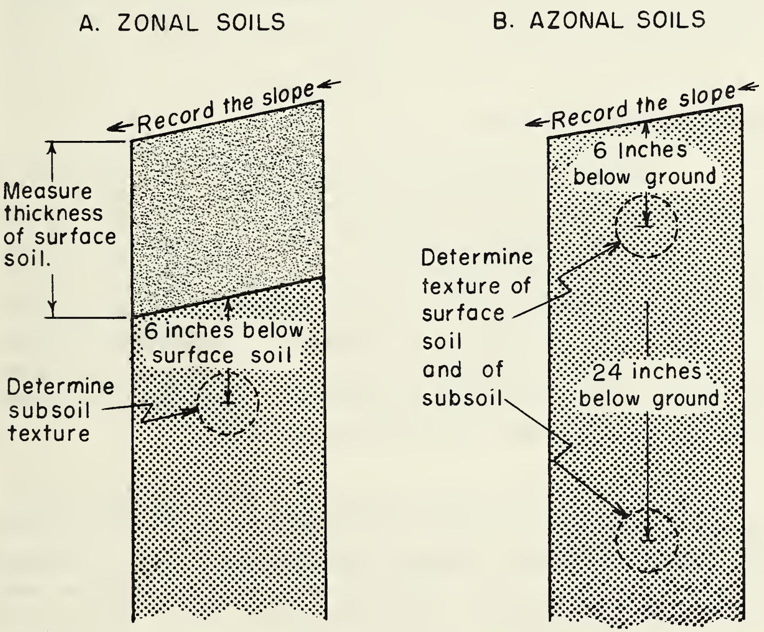


Figure 3.--Summary of field procedures for classifying sites.

well within the subsoil. If there is only one obvious subsoil layer, the texture determination is made about 6 inches into this layer. If there are several subsoil layers, the determination is made in that with the highest clay content, or the least permeable horizon. The Appendix gives details of texture recognition.

If the profile development is azonal, two texture determinations are necessary, one for the surface soil and one for the subsoil. Because the transition between the two layers is indistinct, the surface soil determination is arbitrarily made at a depth of 6 inches, the subsoil at a depth of 24 inches (fig. 3B).

RECOGNITION OF SLOPE

In classifying the general slope of a site, topographic position and surface drainage should be taken into account. Slope classes are broad in the zonal group: 1-5, 6-10, and 11-15 percent. While it is not practical to measure the slope carefully at each sampling point, an Abney level should be used periodically to check ocular estimates. It is usually quite simple to determine a slope class with the aid of general land features, as those depicted in figure 2D.

In the azonal group, slope classes are narrow, and more judgment is required to classify slope. Relatively minute changes in drainage have a large effect on site, and a hand level should probably be used. Perfectly flat areas of poor surface drainage, where water stands after heavy rains, make up one

class. Slope percent here is zero. A second class is made up of flatwoods and terrace areas of imperfect surface drainage, exhibiting gentle slopes of 1 to 2 percent. Where topography is more rolling, definitely not flatwoods or terrace, a third class is recognized. Surface drainage is good in this class, with slopes of 3 to 5 percent generally prevailing.

RECORDING DATA

In field application, a system of coding site variables is usually employed. Soils and topography are inspected at sampling points, and areas of uniform characteristics are delineated. It is desirable to have as simple a record as possible, yet one that adequately describes field conditions.

When soil texture is identified in the field, it is simple to record its abbreviated form:

S	= sand	LtC	= light clay (up to 50 percent clay)
LS	= loamy sand	HC	= heavy clay (over 50 percent clay)
SL	= sandy loam	SiC	= silty clay
SCL	= sandy clay loam	SiCL	= silty clay loam
L	= loam	SiL	= silt loam
CL	= clay loam	Si	= silt
SC	= sandy clay		

Soil thickness and slope percent can readily be coded as they are found; for example, "16" could mean a surface soil 16 inches thick, and "4" could mean a 4-percent slope. Their positions in the coding symbol prevent the two measurements from being confused.

It is logical to place surface soil characteristics over subsoil characteristics, as the numerator

and denominator of a fraction. Thus $\frac{12}{HC}$ means 12 inches of surface soil overlying a heavy clay subsoil. Because the presence of the figure "12" indicates that the soil is zonal, direct reference to zonal or azonal is unnecessary. When slope class is added, the symbol becomes $\frac{12}{HC}$ 1-5, if the slope is generally 1 to 5 percent.

The symbol $\frac{SiL}{SiC}$ 0 means silt loam surface soil underlain by a silty clay subsoil. The soil is azonal, because texture instead of thickness is given in the numerator. The "0" indicates that the site is a poorly drained flat area.

HOW TO ESTIMATE SITE INDEX

When soil measurements have been made and recorded, loblolly pine sites on zonal soils can be estimated from table 1, loblolly pine sites on azonal soils from table 2, and shortleaf pine sites on zonal soils from table 3. [2]

The tables give values of site index for simple classes of soil thickness and texture and of slope percent. For example, a site classified as $\frac{18}{SCL}$ 1-5 would have a site index of 90 for loblolly pine (table 1) and 82 for shortleaf pine (table 3). A site classified as $\frac{SiL}{SiC}$ 0 would have a site index of 69 for loblolly pine (table 2).

Shortleaf pine is an infrequent associate of loblolly pine on azonal soils, and its index on such

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[2] The standard errors of the regression estimates on which tables 1, 2, and 3 were based are $\pm$ 4.5, $\pm$ 3.5, $\pm$ 3.0, respectively.

Table 1.--*Site index of loblolly pine on zonal upland soils*

Textural grade of subsoil	Slope	Thickness of surface soil				
		6 inches	12 inches	18 inches	24 inches	30 inches
	Percent			*Site index*		
Loam (10-20 percent clay)	1-5	74	81	84	82	75
	6-10	70	77	80	78	72
	11-15	67	74	76	74	68
Sandy clay loam (20-30 percent clay)	1-5	81	87	90	88	82
	6-10	77	84	86	84	78
	11-15	73	80	83	81	74
Clay loam (30-40 percent clay)	1-5	80	87	89	87	81
	6-10	76	83	86	84	77
	11-15	72	79	82	80	73
Light clay and sandy clay (40-50 percent clay)	1-5	76	83	85	83	77
	6-10	72	79	82	80	73
	11-15	68	75	78	76	69
Heavy clay (over 50 percent clay)	1-5	72	79	82	80	73
	6-10	69	75	78	76	70
	11-15	65	72	74	72	66

Table 2.--*Site index of loblolly pine on azonal upland soils*

Textural grade of subsoil	Slope	Textural grade of surface soil		
		Sandy loam	Loam	Silt loam
	Percent	- - - -	*Site index*	- - - -
Sandy loam to sandy clay loam (30-50 percent silt-plus-clay)	0	80	73	([1])
	2	87	79	
	4	81	74	
Loam to clay loam (50-70 percent silt-plus-clay)	0	90	85	
	2	96	91	
	4	91	86	
Clay (70-80 percent silt-plus-clay)	0	86	82	79
	2	92	89	85
	4	86	83	80
Silty clay loam to silty clay (Over 80 percent silt-plus-clay)	0		70	69
	2		77	75
	4		71	70

[1] The blank spaces indicate combinations of surface silt and subsoil silt-plus-clay that do not occur in nature.

Table 3.--*Site index of shortleaf pine on zonal upland soils*

Textural grade of subsoil	Slope	Thickness of surface soil				
		6 inches	12 inches	18 inches	24 inches	30 inches
	Percent	*Site index*				
Loam (10-20 percent clay)	1-5	71	76	78	77	74
	6-10	64	69	71	70	66
	11-15	62	67	69	69	65
Sandy clay loam (20-30 percent clay)	1-5	75	80	82	81	77
	6-10	67	72	75	74	70
	11-15	66	71	73	72	68
Clay loam (30-40 percent clay)	1-5	76	81	83	82	78
	6-10	69	74	76	75	71
	11-15	67	72	74	74	70
Light clay (40-50 percent clay)	1-5	75	80	82	81	77
	6-10	67	73	75	74	70
	11-15	66	71	73	72	68
Heavy clay (Over 50 percent clay)	1-5	71	76	78	78	74
	6-10	64	69	71	70	66
	11-15	62	67	70	69	65

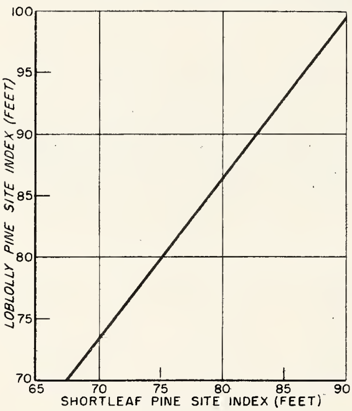

Figure 4.--Relationship between the site indices of loblolly and shortleaf pines in mixed stands.

sites is considered unimportant. The relationship between the two species on all sites, zonal and azonal, where they occur in mixed stands, is given in figure 4. This relationship may prove useful in estimating the site index of one species from that of the other.

The tables are not intended for bottomland soils. Floodplains of minor streams are superior loblolly pine sites in the region studied. Usually such bottoms can be safely classified as site 95 or better. The floodplains of major streams usually have no pine.

The size of the area to be mapped will of course regulate the sampling procedure. A small abandoned field of five acres, for example, may be adequately sampled by 8 or 10 sampling points scattered over the area. A 40-acre tract can probably be intensively mapped by sampling at two-chain intervals along cruise lines five chains apart; this intensity will give 40 systematically spaced samples, or one per acre. Larger areas can be adequately sampled with a somewhat smaller number of borings per acre, depending on the accuracy required.

A soils map is usually first made of the area to be classified. The field cruise provides all the information necessary for site-quality estimates. As an example, figure 5A shows a 40-acre tract that has been mapped for soils and slope. Figure 5B then follows as a loblolly pine site-class map. It was made by using tables 1 and 2 to convert the data on the soils map.

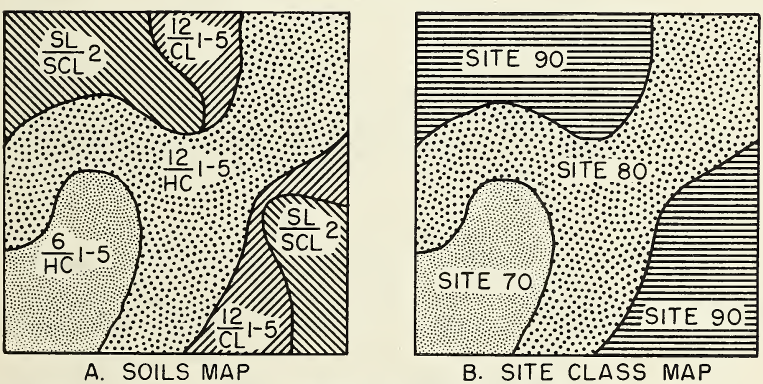

Figure 5.--How a soils map can be transformed into a site-class map for loblolly pine.

LIMITATIONS

It should be kept in mind that the system described in this paper gives site estimates for average pine stands receiving average treatment. Actually, site index is modified by many influences that operate throughout the life of a stand: the genetic background of the trees, cycles of wet and dry weather, grazing, fire, logging, ice, insects, and many others.

SUMMARY OF FIELD PROCEDURES

This paper shows how site index may be estimated for loblolly and shortleaf pines in the upland Coastal Plain of south Arkansas and north Louisiana. Classification is based on permanent and mappable features of soil and topography. At each sampling point on an area to be classified, the procedure is as follows:

1. Check horizon development to determine whether soil is zonal or azonal.

2. If the soil is zonal, measure average thickness of surface soil within a 6-inch class; if azonal, determine textural grade of surface soil at a depth of about 6 inches.

3. Determine textural grade of subsoil. In zonal soils, avoid the transition between surface soil and subsoil by making the determination at least 6 inches into the subsoil. On azonal soils, assume that the 24-inch depth is the subsoil and make determination there.

4. Measure the average slope of the site. If soil is zonal, measure within a 5-percent class; if azonal, determine whether slope is zero, slight (2 percent), or moderate (4 percent).

5. Record this data symbolically, by placing the surface soil characteristic over the subsoil characteristic, and following with the slope class.

6. Transform the coded data of each sampling point into estimated site index by means of tables 1, 2, and 3.

APPENDIX

Soil texture refers to the relative proportions of sand, silt, and clay particles which make up the soil mass. Figure 6 shows the percentages of these soil fractions in the basic textural grades; definitions and discussion of this subject may be found in the Soil Survey Manual (Agriculture Handbook 18, U.S. Department of Agriculture, 503 pp., 1951).

Soil texture can be found exactly in a laboratory analysis. It can also be adequately classified in the field, after some experience, by sight and feel. On the opposite page is a key to the important textural grades. The first three--sandy loam, loam, and silt loam--are common surface soils, and may occur as subsoils. The rest are subsoils.

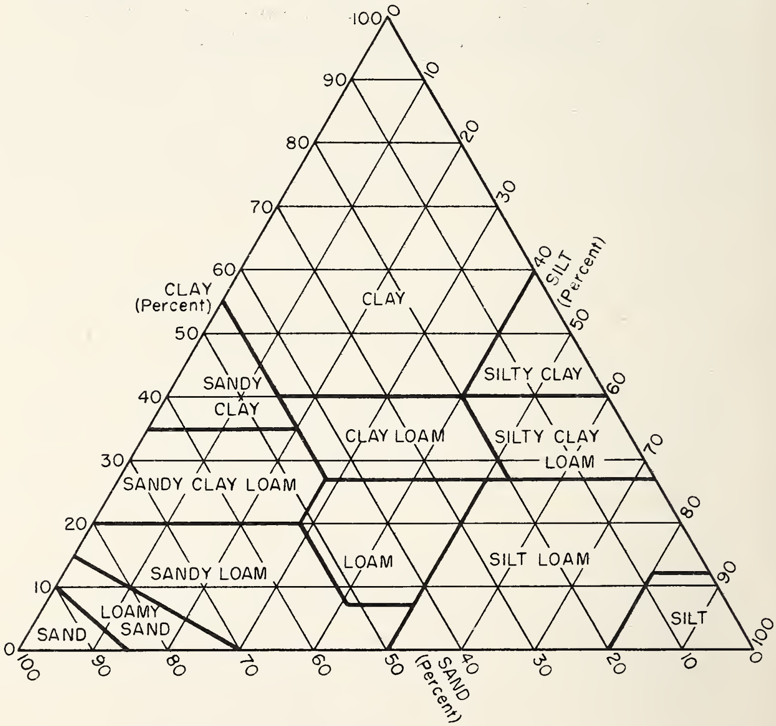

Figure 6.--Textural classification of soils.

DICHOTOMOUS KEY FOR
FIELD IDENTIFICATION OF SOIL TEXTURE

A. *SOIL, WHEN PINCHED BETWEEN THE THUMB AND FINGER, CRUMBLES, WILL FORM NO 'RIBBON.'*

B. SOIL, SQUEEZED IN HAND WHEN DRY, FALLS APART READILY; SQUEEZED WHEN MOIST, FORMS A CAST THAT BREAKS IF NOT HANDLED VERY CAREFULLY. INDIVIDUAL SAND GRAINS CAN BE READILY SEEN AND FELT....................... **SANDY LOAM.**

B. SOIL, SQUEEZED IN HAND WHEN DRY, FORMS CAST THAT BEARS CAREFUL HANDLING; SQUEEZED WHEN MOIST, FORMS A CAST THAT CAN BE HANDLED QUITE FREELY WITHOUT BREAKING. SOIL SMOOTH, SAND GRAINS NOT READILY EVIDENT.

C. ***SOIL SLIGHTLY PLASTIC WHEN MOIST, BUT NOT GREASY. GRITTY WHEN DRY, NOT FLOURY. COLOR BROWN OR DARK GREY***... **LOAM.**

C. ***SOIL GREASY WHEN MOIST, FLOURY WHEN DRY. ON WETTING IT RUNS TOGETHER AND PUDDLES. COLOR LIGHT GREY TO NEARLY WHITE***............................ **SILT LOAM.**

A. *SOIL, WHEN PINCHED BETWEEN THE THUMB AND FINGER, FORMS A 'RIBBON,' AT LEAST BARELY SUSTAINING ITS OWN WEIGHT.*

D. RIBBON BREAKS EASILY, BARELY SUSTAINS OWN WEIGHT.

E. ***INDIVIDUAL SAND GRAINS CAN READILY BE SEEN AND FELT. MOIST SOIL FRIABLE. COLOR USUALLY BROWNISH YELLOW TO BROWNISH RED***........................ **SANDY CLAY LOAM.**

E. ***SOIL SMOOTH, SAND GRAINS NOT EVIDENT. MOIST SOIL SOMEWHAT PLASTIC.***

F. Soil heavy and greasy when moist. Color dull grey, sometimes containing iron concretions.... **SILTY CLAY LOAM.**

F. Soil mellow and loose when moist. Color usually yellowish brown to reddish brown...................... **CLAY LOAM.**

D. RIBBON IS LONG AND FLEXIBLE, STRONG.

G. ***INDIVIDUAL SAND GRAINS CAN READILY BE SEEN AND FELT. MOIST SOIL SOMEWHAT FRIABLE. COLOR USUALLY BRIGHT RED OR YELLOW***.................................. **SANDY CLAY.**

G. ***SAND NOT EVIDENT. MOIST SOIL PLASTIC.***

H. Color usually grey, sometimes containing iron concretions.................................. **SILTY CLAY.**

H. Color usually dark red, often mottled with grey or yellow.. **CLAY.**